FEDERAL FIRE COUNCIL

minutes of
annual meeting
april 5, 1967

AD 660 933

"MISSILE SILO FIRE AT LITTLE ROCK AFB, ARKANSAS"

AND

"FIRE PROTECTION PROBLEMS FOR SPECIAL ATMOSPHERES -- INCLUDING OXYGEN"

FEDERAL FIRE COUNCIL | Washington, D.C. 20405

ABSTRACT OF FEDERAL FIRE COUNCIL'S ANNUAL MEETING - APRIL 5, 1967

OPENING REMARKS

William A. Schmidt

Chairman William A. Schmidt welcomed members and guests to the 31st Annual Meeting of the Federal Fire Council.

He reviewed briefly some of the fire safety legislation pending in Congress. Included were:

Senate Bill 1124 for a Fire Research and Safety Act with $10 million proposed for an expanded National Bureau of Standards program.

Senate Joint Resolution No. 46 to create a 20 member National Advisory Commission on Fire Prevention and Control.

House Joint Resolution No. 280 to establish a National Commission on Product Safety.

House of Representatives Bill No. 6421 to ammend the Flammable Fabrics Act.

And others.

Mr. Schmidt urged Council members and Committees to reexamine fire's annual toll of deaths, injuries, and financial losses with a view toward enabling fire safety programs to compete for dollars in agency budgets.

The annual committee reports were approved with permission for desirable editorial work.

MISSILE SILO FIRE AT LITTLE ROCK AFB, ARKANSAS The study gives

Lt. Col. Moses R. Box

Lieutenant Colonel Moses R. Box, propulsion engineer with the Missile and Space Safety Division, Directorate of Aerospace Safety, Norton Air Force Base, California, was introduced. He presented an illustrated talk on the Missile Silo Fire at Little Rock, Arkansas. The report

During his talk, Colonel Box emphasizes the need in fire prevention to properly identify hazards involved in the use of materials and recognize inherently hazardous tasks; showed how hazards for welding are increased in an enclosed space by the presence of hazardous materials; and showed why hazard analysis, application of adequate safety standards, and work scheduling procedures are necessary.

The Air Force, he said, uses a system analysis approach in implementing safety. This requires analysis of the following: A breakout of the entire job by tasks and the evaluation of each task to determine the hazards involved; corrective actions necessary to minimize or eliminate any identified hazards; a schedule to preclude hazards which could result from task overlap; manloading based on egress, the existing hazard, and the minimum number of personnel required to accomplish the task; and special precautions required such as identification of special protective equipment, the development of management's organization and controls, and special safety training required for a particular job.

Excellent motion pictures were shown of the verification tests conducted at Edwards Air Force Base.

FIRE PROTECTION PROBLEMS FOR SPECIAL ATMOSPHERES -- INCLUDING OXYGEN

Thomas Goonan

Mr. Thomas Goonan, of the Department of Medicine and Surgery, Veterans Administration, briefly reviewed some recent fires in special atmospheres as an introduction to his talk.

"I expect," he said, "the special atmospheric conditions in space work to be eliminated eventually." However, he predicted increased future application for special atmospheres in medicine and undersea exploration and exploitation.

Mr. Goonan defined various terms and explained that the partial pressure of oxygen in ordinary atmosphere is about 3.09 pounds per square inch. A gas mixture having an oxygen partial pressure more than this amount is generally more hazardous than air and one having an oxygen partial pressure less than this amount is generally less hazardous, he said.

Next, the similarities between deep sea diving, hospital hyperbaric chambers, and the space program were explained. They are: High partial pressure of oxygen; isolation, or inability to escape quickly from the environment; and difficulty in providing fire protection.

Mr. Goonan discussed various aspects of several fires to emphasize that it is important to know what caused the fire; it is more important to know how it progressed. "If we concern ourselves more with providing necessary exits, reducing the fire spread potential, eliminating the possibility of panic, and providing protective measures," he said, "we are much closer to achieving fire safety."

His suggestions for fire protection in special atmospheres included the following: Do not depend on a program of 100% fire prevention; reducing the partial pressure of oxygen to three pounds per square inch absolute; reduce amount of combustibles in the chamber; clothing should be kept to a minimum, be tight fitting, and the most flame retardant available; a built-in, fast operating automatic protective system is necessary; and first aid fire extinguishing equipment.

QUESTIONS AND ANSWERS

Several interesting questions were asked. Both speakers made additional comments on the points raised.

FILM PREMIER

Next was the premier showing to Federal personnel of the motion picture "Testing - Requisite for Fire Safety." This film, was produced by Underwriters' Laboratories, Inc. to explain their operations on behalf of the fire safety team -- architects, engineers, building code interests, firefighters, and others.

FEDERAL FIRE COUNCIL
Minutes of Annual Meeting

Auditorium, General Services Administration Building
Washington, D. C.
Wednesday, April 5, 1967

CHAIRMAN SCHMIDT: Good morning, ladies and gentlemen. I'd like to welcome you to the 31st annual meeting of the Federal Fire Council.

Before conducting the business for our annual meeting and hearing the scheduled speakers, I would like to make some observations. You may be aware that there are more fire safety bills and resolutions pending in this, the 90th Congress, than in any previous Congress. These bills cover the entire spectrum of fire safety and related fields.

Senate Bill 1124, for example, proposes to amend the act of the National Bureau of Standards to authorize a Fire Research and Fire Safety Program with initial authorization of $10 million for fiscal year 1968. This bill was introduced by Senators Magnuson and Cotton, and I understand that they are having hearings today on this particular piece of legislation.

Senate Joint Resolution No. 46 was introduced by Senator Sparkman to establish a National Advisory Commission on Fire Prevention and Control. This advisory commission is to have 20 members -- one of whom is to be the Secretary of Housing and Urban Development -- with 19 other members appointed by the President. Not more than eight members of the Commission would be representatives from the Federal Government. The Commission would have a period of 18 months to study this nation's fire problem and submit their report back to the President.

House Joint Resolution No. 280 introduced by Congressman Moss requests the establishment of a National Commission on Product Safety. This Commission would conduct a comprehensive study and investigation of the scope and adequacy of measures now employed to protect consumers against unreasonable risk of injuries which may be caused by hazardous household products. A final report would be transmitted to the President and the Congress not later than January 1, 1969, by this Commission, composed of seven people appointed by the President.

House of Representatives Bill No. 6421, introduced by Congressman Adams, seeks to amend the Flammable Fabrics Act to increase the protection afforded consumers against injuries from flammable fabrics. Important points in this proposed legislation are: The Secretary of Commerce shall prescribe flammability standards; and the Secretary of Health, Education, and Welfare in cooperation with the Secretary of Commerce shall annually conduct a study and investigation of the deaths, injuries, and economic losses resulting from accidental burning of products, fabrics, or related materials and submit a report to the President and Congress containing the results of the study and investigation as well as suggested revisions to standards to adequately protect the public.

House of Representatives Bill 6551 seeks to amend the Natural Gas Act to authorize the Federal Power Commission to prescribe safety requirements for natural gas companies.

House of Representatives Bill 6554 seeks to protect the safety and welfare of American workers by providing for a uniform system of identification for all receptacles containing compressed gas

These and many other resolutions and bills have been introduced in the 90th Congress, and I think you will agree that they can have a widespread effect on reducing the loss of life and property from fire in the United States.

These legislative proposals indicate a growing concern over the problem of fire safety. There must be some way of putting a better handle on the fire safety problem in the Federal Government than we have today before we can hope to satisfactorily alert managers and administrators to the need for adequate funding and adequate attention to this problem. With a total of 18,123 fires causing 323 deaths, 1,452 injuries, and a dollar loss of over $235 million for fiscal year 1966, I doubt if anyone will say, "We really don't have a fire problem in the Federal Government."

I urge Council members and committees to consider this during the coming year. Hold discussions, talk informally, and perhaps we can get a clearer picture of just what the fire situation is and how it should compete for dollars in the budget programs for each agency.

We've got a very busy program this morning, so I'd like to get right to the annual reports of the Council's standing committees covering our operations last year -- the 30th anniversary year. These annual reports have been printed and distributed to the membership prior to this meeting, and I hope that you have had the opportunity to review and consider them.

I'd like to identify the individual reports and the committee chairmen for the record. The committees and chairmen are: The Executive Committee chaired by Bill Hanbury; the Committee on Design Standards chaired by Bud Nelson of the General Services Administration; the Committee on Education and Training chaired by Joe Caldwell of the Federal Aviation Agency; the Committee on Field Activities chaired by Ed Huddleston of the Department of Health, Education, and Welfare; the Committee on Fire Loss Experience chaired by Larry Hicks of the Department of the Navy; the Committee on Fire Prevention chaired by Dick Smith of the Atomic Energy Commission; the Program Committee chaired Paul McDonald of the Treasury Department; the Committee on Protection of Records chaired by Charles Sterman of the General Services Administration; the Committee on Research and Technology chaired by Dick Tuve of the Department of the Navy, and the Committee on Systems and Equipment chaired by Harry Shoub of the Department of Commerce. Also included with the other reports is one on the staff activities by Ed Bolles, Assistant Staff Director of the Council.

Are there any comments or discussions on the reports? If not, the Chair will entertain a motion on the acceptance of the reports for printing.

(So moved.)

CHAIRMAN SCHMIDT: Is there a second?

(Seconded.)

CHAIRMAN SCHMIDT: Before I call for a vote, I would like to suggest that there may be some editorial work that is desirable in the final reports, and I would like to be sure that the motion that has been made would permit this work. Is there any objection to that?

(No objection.)

CHAIRMAN SCHMIDT: All in favor, say Aye. (Chorus of "aye's.) Opposed, no. (Silence.)

The motion is carried. (See Appendix A for Annual Committee Reports.)

I'd like to move on to the principal part of our meeting this morning. I think our Program Committee has arranged for a very interesting and informative program, and we are grateful to our speakers for being here to meet with the Council.

Our first speaker will be Lieutenant Colonel Moses R. Box, and he will bring to us a look at the Missile Silo Fire at Little Rock, Arkansas. Colonel Box is substituting for Colonel Charles F. Strang. I understand Colonel Strang was tied up at the last minute with the Apollo accident investigation and couldn't be with us today.

Colonel Box is a propulsion engineer for the Missile and Space Safety Division, Directorate of Aerospace Safety, Headquarters, U.S. Air Force at Norton Air Force Base, California.

His previous experience includes research and development work from 1954 to 1960; assignment to the Titan Development Program from 1960 to 1963; and from 1964 to the present with the Directorate of Aerospace Safety.

Colonel Box graduated with a Bachelor of Science Degree from Mississippi State University, and with a Master of Science Degree from Oklahoma State University. He was a member of the Titan II Accident Investigation Board.

Colonel Box.

COLONEL BOX: Could we have the slides, please?

Gentlemen, Colonel Strang regrets that he is unable to be here today. He is tied up with the Apollo 204 Review Board down at the Cape. I will, with your permission, present the same briefing that he had planned on giving today.

The Air Force is vitally interested in conserving Air Force resources and preventing accidents or mishaps.

In spite of our safety efforts, accidents have occurred requiring detailed accident investigations. These investigations are conducted to determine the cause factors and corrective actions necessary to preclude future accidents of a similar nature.

One aspect of fire and accident prevention is to disseminate the lessons learned to groups such as assembled here today. The cause and methods of preventing the recurrence of accidents similar to the Titan II launch facility fire at Little Rock Air Force Base, 1965, are of interest to you as personnel involved with fire prevention.

During my briefing, I will show how, in fire prevention, it is important to properly identify the hazards involved in the use of materials and the need to recognize inherently hazardous tasks. I say this because the hydraulic fluid involved in the Titan II accident is not rated as a flammable liquid by the National Fire Protection Association definitions. However, under certain conditions, it is hazardous. Next, I will show how the degree of hazard for welding in an enclosed space is increased by the presence of hazardous materials. Third, I will show why a hazard analysis, application of adequate safety standards, and work scheduling procedures are necessary.

The Titan II launch facility fire at Little Rock Air Force Base occurred while the missile complex was undergoing a modification entitled "Yard Fence", and took the lives of 53 workmen.

This (See Figure 1) is a cutaway view of the operational Titan II underground complex. The center portion is a launch duct which contains the missile. Surrounding the launch duct is the equipment area.

An entrance to the cableway is at Level 2. Beside the entrance of the cableway, there is an elevator which goes from the second to the eighth levels and has a capability of carrying six persons. The cableway at Level 2 provides passage to the access portal area and then back from the portal area to the launch control center. Normal access to and from the surface is up the stairs in the access portal area.

One of the purposes of the "Yard Fence" modification program was to increase silo hardening; that is, ability of the entire underground installation to withstand the effects of a nearby nuclear detonation through a "find and fix" program.

This program varied from site to site and included the addition of structural steel reinforcements at various points of the hardness structure. Other modifications in the "Yard Fence" program included improvement and repair of the hydraulic and electrical systems, and modification of acoustical liners on the inside of the launch duct.

"Yard Fence" was initiated in November of 1964, and the contract was let in January 1965. At the McConnell Air Force Base complexes, work was started in March and completed in June 1965. Work was initiated at Little Rock in June. At the date of the accident, work on two complexes was completed and two were undergoing modification. Work on the site of the accident had commenced on July 16. The re-entry vehicle was removed. However, the missile and its fuel and oxidizer remained in the silo.

The lunch hour was from 12:00 to 12:30. At 12:30, the workmen returned from above ground, and, presumably, by 12:45 were back at work.

Information derived from work schedules and body positions indicated the distribution of the men as follows: (See Figure 2) On Level 1 there was one man; Level 2, there were 12; Level 3, there were 24; Level 4 had 8 people working; Level 5 had 1; Levels 6 and 7 had 4 each; no people were working on Levels 8 and 9; and 1 man was in the elevator between Levels 5 and 6. The elevator was stalled due to lack of power.

The four-man launch crew was working in the launch control center, Level 2, their normal duty stations. (See Figure 3). The maintenance crew of five men which was on the site was having lunch at Level 1 and were not involved in any way in this accident.

One of the workers -- we'll call him Mr. A -- who survived this accident, testified that shortly after 1300 hours, he left the access portal area and went through the cableway to Level 2 of the silo, (See Schematic, Figure 4), in search of a mop and bucket. He was a cleanup man. He went around the launch duct and approached a group of men standing around the top of the emergency escape ladder which extended vertically down to Level 7 in Quadrant IV. This ladder was used as an emergency escape route when the elevator is not in operation. This man was standing at the top of the ladder facing outward from the launch duct.

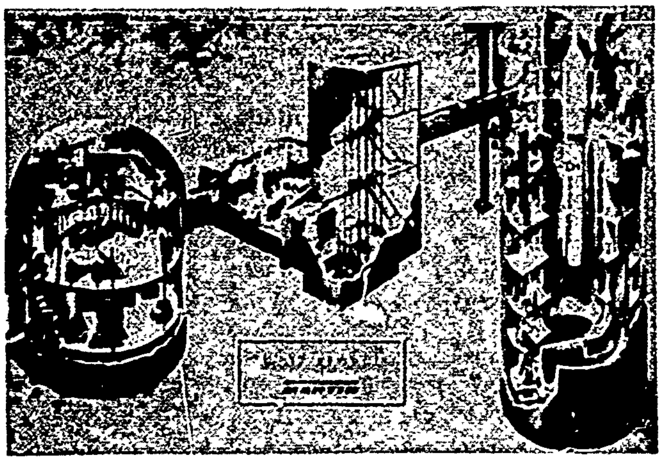


Fig. 1

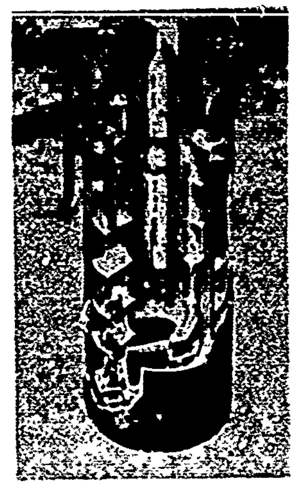


Fig. 2

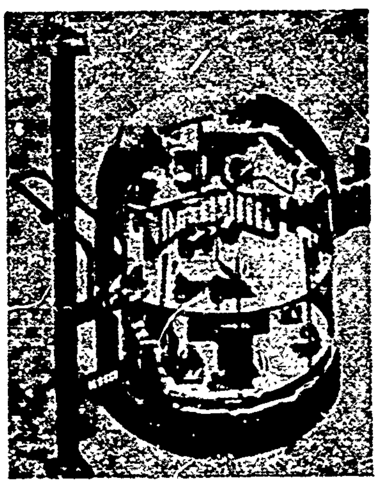


Fig. 3

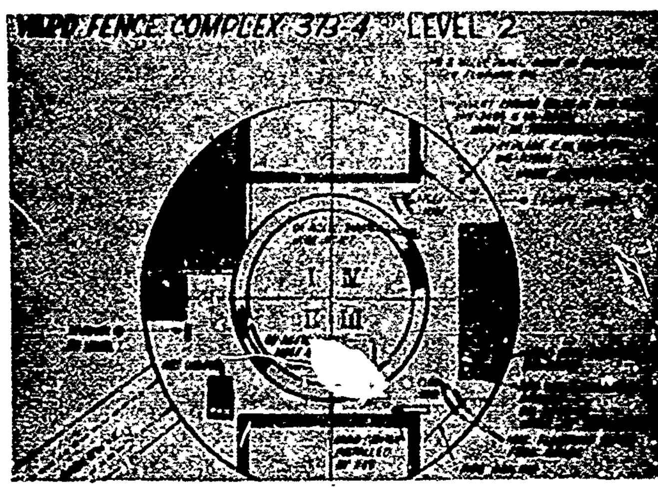


Fig. 4

Fig. 5

Fig. 6

He stated that he heard a puff of wind. He turned around to his right, and looking in the direction of the water chillers, he states he saw yellow-colored flames reaching to the ceiling. They quickly subsided to a height of about four feet.

The men who were congregated around the emergency ladder made a rush for the ladder. Mr. A, realizing that he would not be able to escape in this direction, decided to return to the cableway by going around the launch duct through the area of the fire. You will note that he could not have gone around the launch duct in the other direction as the collimator room walls block passage. He made his way in darkness, through fire and smoke, to the cableway and then on to the launch control center. He suffered numerous, but not severe, burns of the hands and face.

The other of the two survivors, of the 55 people in the silo, was working on Level 1. He stated that he heard and saw nothing. After the lights went out, he smelled smoke. He made his way down the ladder to Level 2 in Quadrant II, then out the cableway. He wasn't overly excited because he arrived at the launch control center still carrying his paint brush and his bucket that he had been using. He suffered from smoke inhalation, but no other injuries.

At approximately 1308 hours, the Missile Combat Crew Commander, the MCCC, saw the "fire in diesel engine area" indicator on his console. The diesel engine is located in Quadrant IV, Level 3. The MCCC sounded the klaxon horn and made three announcements on the voice signaling system ordering evacuation of the silo.

Shortly afterward, several attempts were made by the crew members to penetrate the silo. Initial attempts were turned back by the heavy smoke in the silo, and heat in Quadrant III of Level 2. It was stated that even with a flashlight, visibility was no more than a couple of feet.

I will not describe rescue operations in any detail except to point out that the investigation revealed most of the people on the four upper levels were probably dead in about five minutes. Those at the lower levels may have survived a few minutes longer. The missile itself sustained no visible damage.

I will now show how we can conclude that the accident was caused by a welder striking a temporarily installed high-pressure, steel-braided hose containing flammable hydraulic oil, causing the hose to rupture and result in a severe flash fire of relatively short duration.

These facts lead to the conclusion.

A rupture in a flexible hose was discovered near the floor of Quadrant III, Level 2.

The hose was used in the contractor's temporarily installed flushing rig to flush and clean the HS-2 hydraulic system. (This system operates the silo blast valves and the movable work platforms in the launch tower.)

This (See Figure 5) is a picture of the ruptured hose before removal for further examination. You are looking toward the outer silo wall from the launch duct in Quadrant III, Level 2. You will notice the flexible hose and rupture.

This slide (See Figure 6) shows the ruptured hose after removal. You will note that the rupture occurred approximately four inches from the attachment. Independent examination by our metallurgical experts, Mr. Berman of the Aerospace Safety Staff and the Materials Laboratory at Wright-Patterson Air Force Base, confirmed this rupture was caused by application of temperatures in excess of 2500°F, such as that created by an electric arc welding rod. Furthermore, the experts state it could not have been caused by an oxy-acetylene torch because there was no charring or burning of the teflon fibers.

I have this specimen up here on the stage today. After the briefing you are free to examine it at your leisure.

Here we have a close-up of the rupture (See Figure 7). Breaks in the steel braids are approximately 1 1/8 inches long. The hose was carrying hydraulic oil under 500 psi.

This (See Figure 8) is a further magnification of the rupture. Note the fused strands of a single braid of the steel covering. The manufacturer of the hose, Titeflex Corporation, has stated that the teflon inner tube is sold by them as a low-pressure hose and rated at 5 psi.

With the steel braid, they rate the hose at over 1000 psi. With a break in the steel braid as shown, they believe 500 psi would rupture the teflon lining instantaneously.

Examination of Levels 2 and 3 in the silo showed large quantities of hydraulic oil spread around, particularly in Quadrants III and IV on both levels. Samples of this oil were sent to the laboratory and were shown to be the same as that being used in the flushing rig. Furthermore, measurements of oil remaining in the rig indicated that approximately 90 gallons were missing.

This slide (See Figure 9) is a cutaway of the temporarily installed flushing rig for flushing and cleaning the hydraulic system. The motor and pump were located at the top. An 1 1/2-inch iron pipe extended from the unit to just above the floor of Level 2. Flexible hose was connected at this point where the rupture occurred.

Our investigation then considered the possibility of welding being accomplished in the vicinity of the rupture. There was concrete evidence that welding was being done in this vicinity, in fact, within 14 inches of the rupture.

You will note in this slide (See Figure 9) that a welding machine is also located topside. An electrical line extends through the hole in the cap down to Level 3, and then is looped back up to Level 2. I will point this out for you. Here is the welding unit, the line goes through the cap, down through a cable race on Level 2, into Level 3, and then is looped back up at Level 3 through the pipe race where the accident occurred.

Here we have a picture (See Figure 10) of the stinger and the welding rod, as it was found, to which this line was connected. You will notice in the background the flexible line and the rupture location.

This slide (See Figure 11) is a cutaway of Quadrant III looking from the outside in. The pressure line is a 1 1/2-inch pipe. The flexible line takes off here and the rupture occurred at approximately this point (indicating). There were two welds being accomplished on triangular plates in this area. The left weld had been completed. The second triangular plate was being welded into position, and was approximately one third complete.

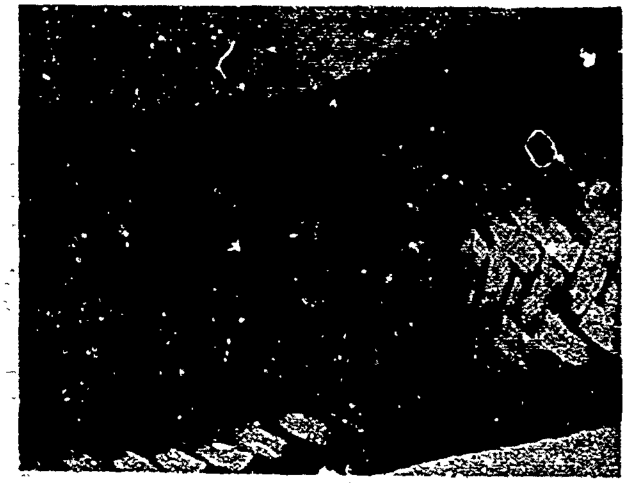


Fig. 7

Fig. 8

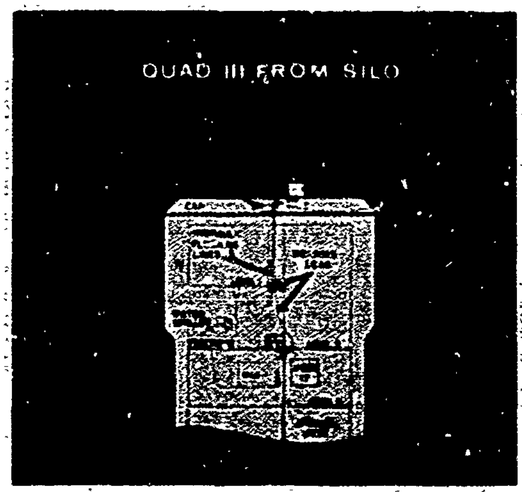


Fig. 9

Fig. 10

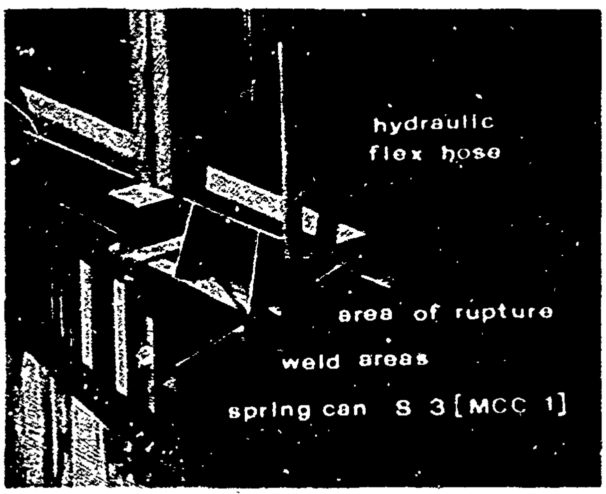


Fig. 11

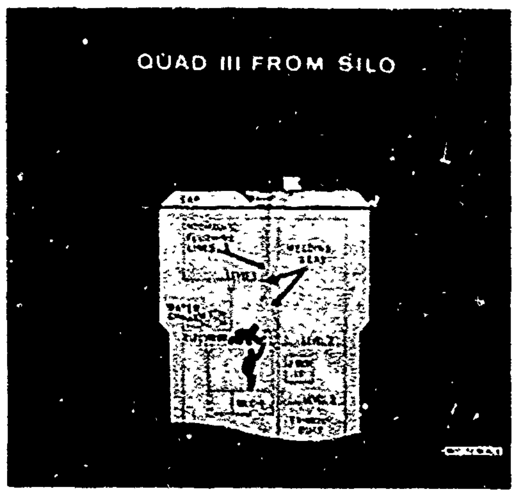


Fig. 12

The pipes near the wall are the normal pipes of the silo used during the propellant loading operations. However, they were purged and contained no fuel.

Our postulation is that a welder first tried to make the weld from below as shown in this drawing (See Figure 12). An expert welder tried this, and stated that although he could work in this vicinity, it was very difficult; in fact, the work area, the plates that he would be welding on, would be only a few inches from his welding hood. We postulate that the welder gave up and proceeded to Level 2 to try from the opening in the floor near the silo wall.

This (See Figure 13) is a picture of an investigator kneeling in this location. We are looking outside from the launch duct. The investigator's left shoulder is next to the silo wall.

Figure 14 is a picture taken from the same location looking along the silo wall. The investigator's hands are in position to weld the plate in question. You will note that he has a stinger in his hand. Here's the plate in question. Here's where the hydraulic line comes down (indicating). The flexible hydraulic line has been removed, but the rupture occurred at this location.

This slide (See Figure 15) shows the triangular plate and the unfinished weld more clearly.

Examination of the fire pattern showed the fire centered around Quadrant III of Levels 2 and 3 (See Figure 16). The MCC-1 in Quadrant III at Level 3 was severely burned. The MCC-1 receives, transforms, rectifies, and distributes all power in the silo. It is located directly below the rupture. The fact that power was disrupted throughout the silo within a minute or less of the initial flash indicates it was badly burned very quickly. Detailed examination of the MCC-1 showed that all identifiable short circuits were a result and not the cause of the fire.

The fire pattern was in complete agreement with our theory.

A welder was scheduled to work on a hardness fix from Level 3. His body was discovered on Level 2 between the rupture and the tunnel. He body was located at this point (indicating). His welding hood which was saturated with hydraulic oil was located at this point (indicating). His clothing and his body were also thoroughly saturated with hydraulic oil.

Here we have a capitulation of the evidence (See Figure 17) so that you can see that the fire resulted from a rupture in a high-pressure flexible steel braided hose containing flammable hydraulic oil which was accidentally struck by a welder's rod.

At this time we have a short film. Before we get into that, I would like to briefly introduce it, since it has no sound track.

Arrangements were made with the Air Force for hydraulic hose rupture and fire tests to be conducted at Edwards Air Force Base. The purpose of this test was to validate cause factors of the accident. The over-all objective of the test was to demonstrate failure of the hydraulic flushing hose and subsequent hydraulic fluid ignition under conditions and environment known to exist at the time of the accident. Specifically, our test objectives were to determine the time and touch of welding arc contact in achieving a similar rupture to the failed hose; the time between the welding

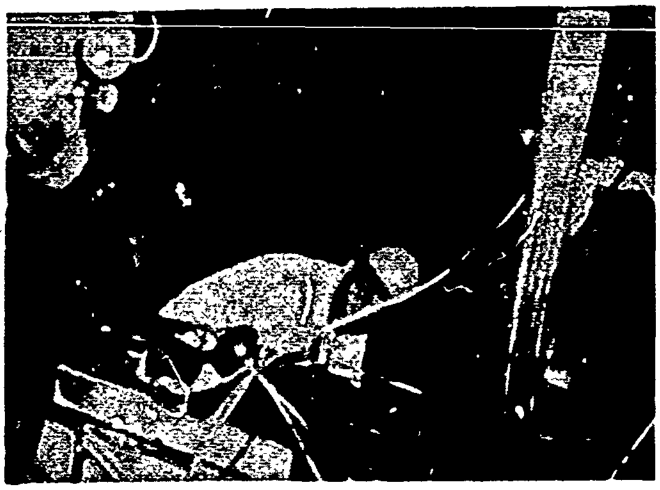


Fig. 13

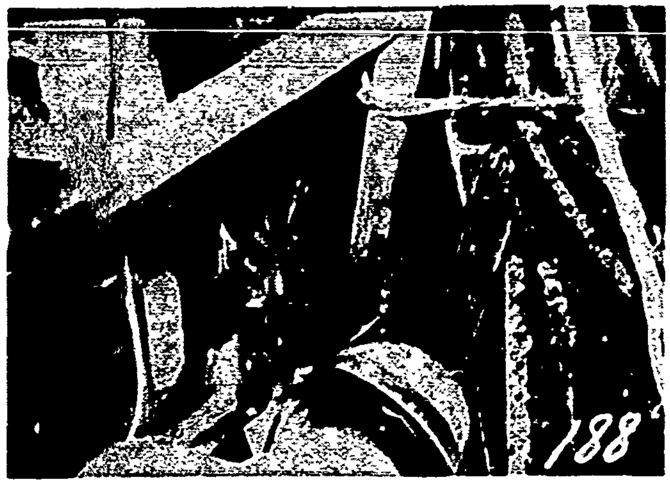


Fig. 14

Fig. 15

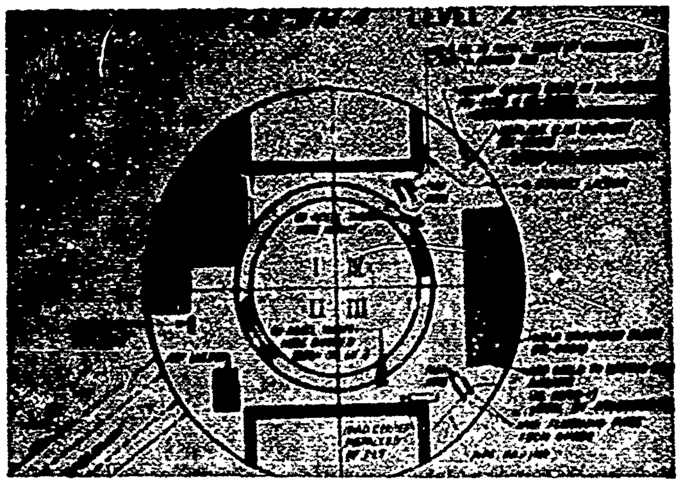


Fig. 16

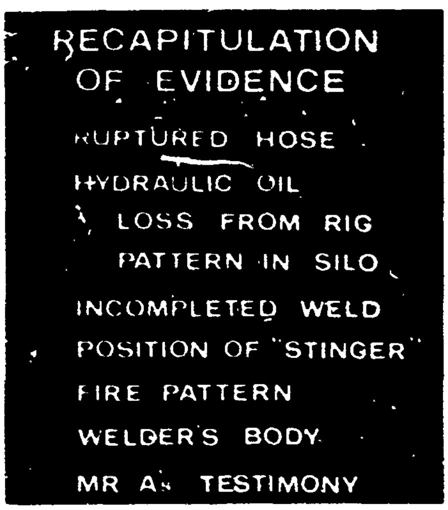


Fig. 17

Fig. 18

arc contact and hose rupture; and between hose rupture and ignition; oil spray pattern achieved from a hose rupture; and the ignition and temperature characteristics of the hydraulic oil, which is MIL-H-6083. The hydraulic flushing unit actually in use at the launch complex at Little Rock was airlifted to Edwards.

Two static tests were conducted and 24 dynamic tests were performed. The two static tests resulted in rupture pressures of the hydraulic hose of 375-381 psig and 275-285 psig, respectively. Of the 24 dynamic tests, 16 hose ruptures occurred which resulted in a total of nine fires. The source of ignition was determined to be the electrode arc or hot metal droplets produced by the arc. The hydraulic oil burned intensely after ignition and a maximum temperature of 2100°F was obtained before the test conductor turned on the water deluge system to save his test cell.

The setting on the welding machine was 127 amps, which duplicated the Little Rock condition. The strands severed on the flexible hose was 140 strands compared to 153 at Little Rock. The time from beginning of the arc to rupture was 0. 69 of a second. The time from rupture to ignition was 0. 02 of a second. Keep this in mind, gentlemen, because the film you will see is in slow motion, and the entire fire from the application of the arc to ignition is less than one second. The total test time was 21. 8 seconds. The total time the current was applied was 1. 08 seconds, and the total hydraulic oil used in the 21 seconds was 23. 6 gallons.

The item you should watch for is the arc, and I'll point this out as the film goes along. Also notice the rupture, the fuel spray pattern, and the fire as it occurs.

Can we have the film now, please? (A silent, color, motion picture film of the fire tests was shown.)

The test unit is in this area (indicating). The stand is to give access to the test facility. You will see ignition in this area. This is Test No. 22. You will notice that the speed is 1800 frames per second. This is relative slow motion. We had some glo-plugs put here to simulate the weld. They did not enter into the test in any way. The rupture will be in this position. You are looking down on the flexible line which was from the same lot of flexible hose that was used at Little Rock. However, it was from specimens that were in the warehouse.

Keep in mind that the application of the electrical current was a little over one second. Here we see the spray pattern of the hydraulic fluid coming back against the wall, and ignition has occurred.

This is another view of the same test with a different camera speed. This is at 1500 frames per second.

Here you are looking down from one side. This is a hydraulic actuator that was used to move the welding rod. This was a simulation of the air conditioning duct which was in the silo. Ignition will occur at this point. Down below you can see a welder's blanket. This was in position during all of the fires and was in good condition at the completion of the fire tests.

Here you see the flaming hydraulic oil spilling down the side of the silo.

This is a final shot of the same test made from a front view at 32 frames per second. We are getting close to normal speed here. There were cutting operations being done in the silo. We installed an oxygen line at this point to simulate an oxy-acetylene torch. We lit it to show that it was producing oxygen. It was put out before the fire occurred. There was some speculation on the Investigation Board that this fire was fed by the oxygen. However, as you can see from the fire picture here, this is like a match in a forest fire. There is relatively little contribution by the oxygen unit to the total fire.

In summary, we feel that the "Yard Fence" program has exhibited a high state of safety awareness and outstanding enthusiasm.

During recent years, the system safety engineering approach to the implementation of safety has been strongly supported by the Directorate of Aerospace Safety. As a result of developing the system safety concept, as well as from experience gained during accident investigation, safety is now being emphasized throughout the life of the system, from the conception through the phaseout.

The Air Force now requires not only a safety analysis of each new system, but a suitable safety analysis for each existing missile system while undergoing modification.

Each analysis, which is a part of the management plan, must contain, but is not limited to, the following: (See Figure 18)

A breakout of the entire job by tasks and the evaulation of each task to determine the hazards involved;

Corrective actions necessary to minimize or eliminate any identified hazards;

A schedule to preclude hazards which could result from task overlap;

Manloading based on egress, the existing hazard, and the minimum number of personnel required to accomplish the task;

Special precautions required such as the identification of special protective equipment, the development of management's organization and controls, and special safety training required for a particular job.

You gentlemen are concerned with safety aspects relating to fire prevention. Your identification of potential fire hazards is necessary to the safety of all operations, whether they be Air Force, other Department of Defense activities, NASA, or industry.

I wish you the best of luck in your fire prevention efforts. Thank you.

MR. SCHMIDT: Thank you, Colonel Box, for your very informative briefing. I am sure that there are a number of questions you would like to ask the Colonel, but I suggest that we hold the questions until after our second speaker.

Our next speaker is Mr. Thomas Goonan of the Veterans Administration. Tom graduated in 1947 with a Bachelor of Science Degree in Electrical Engineering from Purdue University. Immediately thereafter he was employed as a Fire Protection Engineer with the Factory Insurance Association, and held that position until 1960. He was Engineer-in-Charge of the Cincinnati office from 1952 to 1960. From 1960 to 1962, Tom was a Fire Protection Engineer with the United States Navy at Pearl Harbor, and from 1962 to 1966 in Washington, D. C. He was employed in 1966 as

General Engineer with the Safety and Fire Protection Division, Department of Medicine and Surgery of the Veterans Administration here in Washington. Tom is Secretary of the Chesapeake Chapter of the Society of Fire Protection Engineers and is an Associate Member of the Institute of Electrical and Electronic Engineers.

Today Tom will discuss "Fire Protection Problems for Special Atomspheres -- Including Oxygen". This subject, of course, is particularly timely in light of the recent Apollo accident.

Tom.

MR. GOONAN: Since this presentation is short on fact and long on opinion, I think it is necessary to say that the views expressed today will be my own and do not necessarily reflect those of the Veterans Administration, the United States Government, or any agency thereof. Neither do they necessarily reflect those of the National Fire Protection Association's Subcommittee on Hyperbaric Chambers, or of the Society of Fire Protection Engineers.

On February 16, 1965, a fire occurred in the inner lock of a diving chamber at the Experimental Diving Unit, Washington Naval Yard. Because of the unusual nature of the fire, I was called to the scene within 15 minutes. I was immediately catapulted into the strange and confusing world of fire in special atmospheres. At the time of the fire, two divers were coming to the surface from a deep dive and had reached 92 feet depth in an atmosphere of 28% oxygen, 36% nitrogen, and 36% helium. The fire was fatal to the two occupants and caused serious injuries to two other divers who attempted rescue.

As you are aware, this is not the best known fire in a special atmosphere. On January 27 of this year NASA suffered a loss of the Apollo Command Module and three astronauts in an atmosphere of 16 pounds of oxygen. Immediately thereafter on January 30, the U.S. Air Force lost two men in a test chamber in seven pounds of oxygen. Similar fires have occurred which did not achive national headlines.

On September 9, 1962, the U.S. Air Force School of Aerospace Medicine had a fire in an altitude chamber charged with five pounds of oxygen in which the two occupants were in-flight suits. Both were hospitalized, one for two weeks. Cause of the fire was electrical. On November 7, 1962, the U.S. Navy Air Crew Equipment Laboratory, Navy Air Medical Center, Philadelphia, had a fire in five pounds of oxygen in which the four occupants dressed in pajamas were injured, two seriously. On April 28, 1966, an unoccupied Apollo Command Module had an electrical fire at Air Research Torrance Facility, Torrance, California. So we have a small history of recent fires in special atmospheres.

Why should a fire protection engineer be concerned about a fire in so exotic an occupancy? The uses today are relatively restricted. Let us consider the future use of special atmospheres. I expect the special atmospheric conditions in space work to be eliminated eventually. As space vehicles become larger and stronger, the need for special atmospheres will be eliminated and we can expect that space work beyond the bare beginnings in which we are now involved will be continued at atmospheric pressures with a normal mix of oxygen and nitrogen. The fire protection problem will then resemble to a great extent that of a ship at sea, in that it will be subject to control by more or less normal methods and that the passengers and crew will have to be able to control the situation as to abandon ship would involve extreme hazard. However, the picture is different for other phases of development.

Medical research has developed a hyperbaric treatment for gas gangrene, which fortunately is not very prevalent. However, research is being done on the effects of oxygenating patients for brain and heart surgery, and other medical procedures which may involve blood stoppage for a period of time. Obviously, highly oxygenated blood and cells will permit a longer blood stoppage, which is an advantage to the surgeon. The effects are not well known at present, and hyperbaric medicine may have already reached its limits, although there are many doctors and scientists who believe otherwise. Many foresee a time when every well-equipped hospital will have a hyperbaric complex.

Undersea exploration and exploitation is only beginning. Experiments are being continued by Jacques Cousteau off Monaco and by the U. S. Navy under Captain Bond off California. Men are living underseas at greater depths and for longer and longer periods to determine the limitations of man and machinery. It is a belief of many in this field that the future of this planet really depends upon developing the food and mineral resources of the continental shelf. Under this concept we may have large colonies and possibly cities on the sea floor, pressurized to balance the water pressure, so that the workers can enter and leave at will, without decompression chambers. It has been demonstrated that men can extend their working time at 300 feet depth from 20 minutes a day to 8 hours a day by living at that pressure and not decompressing between work shifts. No one knows what the ultimate depth limits may be, but the present state-of-the-art will support experimental dives down to 1000 feet -- approximately 30 atmospheres -- with an anticipated limitation of 1200 feet. At great depths, physiological limits come into play. Nitrogen narcosis, or rapture of the deep, has been well publicized, and this begins to occur in the vicinity of 100 feet depth. Extended dives at 200 to 350 feet have been made on oxygen-helium mixtures, but helium narcosis develops at greater depths. The only gas available for operating at great depths is hydrogen, and you will be hearing more about hydrogen-oxygen breathing mixtures in the future. If men venture below 1200 feet without a pressure-resistant environment, he will most likely breathe water through artificial gills, and the fire hazard will be nil.

One thing confuses discussion of special atmosphere conditions. A variety of measuring units is used. The Navy calibrates dives by depth in feet of fresh water, or in feet of salt water. The Air Force measures flights in feet of altitude. Sand hogs measure in pounds per square inch gauge. Engineers generally use pounds per square inch gauge and pounds per square inch absolute. Hospital hyperbaric treatment chambers are usually measured in atmospheres. Doctors and scientists normally measure these conditions in millimeters of mercury. In reviewing available literature in the field, you will be utterly confused unless you have some guidepost to go by.

A part of this discussion will be concerned with the terms "partial pressure" and "absolute pressure". For those of you who have forgotten that you ever heard the terms, I will review them.

Absolute pressure is pressure measured from absolute zero, or vacuum. If I hold up a gauge, it will read zero, as the pressure in this room acts upon all of its parts equally. If I put the same gauge into a vacuum chamber and pipe it to the outside air, it will read about 14.7 pounds per square inch, the pressure all around us. So when I take a gauge reading of a pressure vessel, if I want the absolute pressure, I must add about 14.7 pounds per square inch to the reading to convert it to absolute pressure.

Partial pressure is the pressure exerted by a single gas in a gas mixture. It is the pressure which would remain in a vessel if we removed all but one of the gases from it. The total pressure of a gas mixture is the sum of the partial pressures of all the gases in the mixture. Partial pressures are always measured in absolute terms.

In ordinary atmosphere, the partial pressure of oxygen is approximately 3.09 pounds per square inch, the partial pressure of nitrogen is approximately 11.5 pounds, and a number of other gases such as neon, krypton, argon, helium and CO_2 make up the small remaining fraction. In understanding the effect of fire in unusual gas mixtures, it is most useful to think in terms of the partial pressure of oxygen. Whether the total pressure is expressed in pounds per square inch gauge or pounds per square inch absolute, in millimeters of mercury, in feet of depth, feet of altitude, or in atmospheres, convert the percentage of oxygen into partial pressure and compare it with the partial pressure of oxygen in air. A gas mixture having an oxygen partial pressure of 3 1/2 pounds per square inch is generally more hazardous than air; a mixture having 2 1/2 pounds per square inch partial pressure is less hazardous. The relation is not absolute, as the diluting gases have some effect, but as a rule of thumb it will serve as the most useful measure to visualize the relative hazards involved.

What is the relation between deep sea diving, hospital hyperbaric chambers, and the space program? We have a certain number of similarities. One common characteristic is a high partial pressure of oxygen. Another similarity is isolation, the inability to escape quickly from the environment. The escape time may be measure in minutes, hours or even days. Also in common is the difficulty in providing fire protection, and up to the present time, the almost total dependence upon fire prevention. With these similarities, what are the differences? The main difference is whether the total pressure of the system is above or below 14.7 pounds per square inch absolute; just the presence of a reference point.

In general, the space program is concerned with special atmospheres in the range of 1/3 to 1 atmosphere. Hospital hyperbaric treatment chambers are generally operated between 1 and 4 atmospheres. The undersea program may range from 1 to 30 atmospheres.

Getting back to the diving chamber fire, the first figure of concern to fire protection engineers is that the chamber contained 28% oxygen. The immediate thought is that there is an 8% excess of oxygen, but on second thought you realize that this is a 40% excess. But consider the total pressure, or the feet of depth in this case, and calculate that the partial pressure of oxygen was 15.31 pounds per square inch, or five times normal. Now we have a better understanding of the condition at the time of the fire, and some rough measure of its probable effect. Instead of an 8% excess of oxygen, or a 40% excess of oxygen, we find that we actually have five times the normal amount, and we can better visualize the fierce fire that ensued. The partial pressure of pure oxgyen at sea level is approximately 14.7 pounds, so that we might expect this fire to be in the same category as one in pure oxygen at sea level. Unfortunately, this was the case.

Little has been officially announced concerning the Apollo space craft fire other than that related to the Senate Committee on Aeronautical and Space Sciences in hearings of February 7 and 27. There are several items of interest to the fire protection engineer in these hearings. In explaining the use of pure oxygen at 5 pounds in the orbiting vehicle and testing in pure oxygen at 16 pounds per square inch in the vehicle on the pad, NASA officials explained that they have operated in pure oxygen for 20,756 hours, manned and unmanned, without incident. When asked about the three previous fires in their program in pure oxygen, they explained that the cause of the fire in each case was determined to be equipment that would not be in the launch vehicle, and therefore the fires were not significant. The entire program was predicated upon the assumption that all ignition sources would be eliminated from the launch vehicle, and therefore the fire hazard would be nonexistent. In fact, the test in which the fire occurred was classified as nonhazardous, and no emergency procedures were established. The fallacy in that approach is, of course, apparent to everyone today, including the laymen. In the future, close attention will be paid to the flame spread characteristics of materials physical separation of combustible materials, the possibility of providing fire extinguishing equipment and the possibility of changing to a two gas system. In all sincerity, it should be stated that there is little probability of the latter two actually coming to pass. With long space flights scheduled, five pounds partial pressure of oxygen has been determined to be intolerable for more than a month, and so two gas systems are projected for future programs. One change that has been decided upon is to stop using pure oxygen at 16 pounds per square inch on the launch pad for the space craft atmosphere.

If we look back to the Navy diving chamber fire, several similarities become immediately apparent. The partial pressure of oxygen in the diving chamber was 15.3 pounds per square inch. The partial and total pressure of oxygen in the space cabin was 16 pounds per square inch. In both cases a flash fire occurred, quick exit was impossible, no fire extinguishing facilities were available to the occupants, and effective help could not arrive from outside in time.

Last week, a Congressional spokesman said that he has been in daily contact with the Apollo fire investigators, and there is no indication they have been able to pinpoint the cause. He said he thinks the thousands of NASA and industry technicians responsible for the Apollo capsule always will have to wonder whether they might have had something to do with the accident. Is that bad? Many contributed to the Apollo fire. If the ignition source had been present, with either the fuel or the oxygen absent, the event would have been only a minor incident.

Fire investigations are often more concerned with the cause of the fire than the total picture. Cause of a fire is interesting, and a great deal of intelligent detective work is demonstrated in pinpointing the cause of a fire, as you have seen on today's program, but the results are quite often misused. If we have, for instance, a fire in a restaurant with one exit on top of a building, and a fire sweeps through the establishment, destroying a number of customers and employees and creating a great deal of property damage, it is interesting to know whether the fire started from a discarded cigarette in the cloak room or whether it started in an overheated deep fryer in the kitchen. However, the basic cause of such a disaster would not be in how it started, but how it progressed, and why it caused the loss of all those people and all that property. If we concern ourselves a little less with the elimination of the possibility of a carelessly discarded cigarette in the cloak room and spend more time in providing the necessary exits, reducing the fire spread potential, eliminating the possibility of panic, and providing protective measures, we are much closer to achieving fire safety. Congressional hearings on the Apollo incident make it clear that the great majority of the fire safety of that program was based upon the elimination of ignition sources, so that when an unexpected ignition source did occur, the results were disastrous. It is desirable to eliminate all the ignition sources possible, but it is nearly always impossible to eliminate ignition sources 100 per cent. Remember, all fires are preventable, after the fact.

We cannot function within a program of 100 percent fire prevention. We can easily function in an environment where, if a fire occurs, the consequences will be minor because of the inherent features we have provided, such as slow flame spread, quick and easy egress, and ready fire suppression methods.

What can be done for fire protection in special atmospheres? A great deal of experimental work has been initiated over the past few years on the fire hazard of materials in special atmospheres. Flame spread has been determined for a number of materials under various conditions of oxygen and pressure, as well as studies of ignition energies required and flammability limits of gases and ignition temperatures. I have seen no tests at all on the effects of mass fire. I attach no significance to this lack, as very little mass fire experimentation is done in ordinary atmosphere because of the great cost involved. You must keep in mind, however, that the fire testing now going on would rate a 2 x 4 wood stud as noncombustible.

Experimental work on extinguishment of fires in special atmospheres is a virgin field. Very little work has been done other than that proposals have been put forward. A few extinguishing systems have been installed and some have been tested in a limited way and nothing so far tested has proved to be ideal. A number of us believe that water, properly applied, will solve most of our problems. When we come to the point of how to properly apply it, we are lost because the necessary experimental work has not been done. Some work has been done on the application of some of the freons for fire extinguishment, but much additional work must be done in determining limitations, both of mechanical equipment and human tolerance.

The first law of human safety from fire cannot be followed in most of these hyperbaric cases: That is, to leave the fire area by the most expeditious means. Under conditions of high oxygen partial pressure, many items not ordinarily considered combustible become highly combustible, and some nearly explosive. The term most often encountered in disastrous oxygen fires is "flash fire". Special atmosphere fires are usually over, for all practical purposes, in less than two minutes. Any practical system, in my opinion, must be automatic, and must be tolerable to the human occupants. If we extinguish fire at the expense of leaving the atmosphere unbreathable, we may be able to save the facility but may not be able to save the occupants.

Fortunately for the fire protection engineer there is a physiological limit to the amount of oxygen that a man can tolerate. Depending on the exposure time, this may be great or small. For long exposures, a partial pressure of 7 pounds per square inch oxygen is about the limit without the subject developing convulsions. Man has developed on this planet with a constant supply of approximately 3 pounds partial pressure of oxygen, and most experiments to date indicate that he operates best in this environment.

This brings up my first proposal for protection -- reduce the partial pressure of oxgyen to 3 pounds per square inch absolute. Instead of pressurizing a hospital hyperbaric unit with compressed air, provide 3 pounds per square inch absolutely oxgyen and the rest an inert gas, such as nitrogen or helium. The rebuttal so far has been that there are no diving tables for decompression from this mixture. That problem is not insoluble, it just calls for time and money to build up a body of experimental data such as has been built up for compressed air and oxygen rich mixtures. It has also been stated that decompression time will probably be longer. This may or may not be true. If it is, there may be ways to avoid a longer decompression time, such as breathing a richer mixture part of the time by mask. Avoidance of a high hazard condition may be worth some penalty in convenience.

It is theoretically possible to eliminate the combustibles from a chamber to the point where the contents will not support combustion. As a practical matter, this approach is an ideal to work toward rather than a standard to simply apply. Even if this goal is achievable, experimental materials and equipment will still find their way into the chamber and result in unanticipated fire exposure.

Clothing and bedding are most difficult to control. There is no common clothing suitable for hyperbaric exposure, and some of the most promising materials are extremely expensive and are unproved as to comfort. Flame retardants provide some improvements in reducing the hazard, but none tested are noncombustible when exposed to increased oxygen partial pressures. Loose fitting clothing is extremely hazardous, as inner layers of clothing have continued to burn rapidly during tests, even under sprinkler discharge. Clothing should be kept to a minimum, be tight fitting, and the most flame retardant available. Belts and pressure bands are helpful in limiting internal flame spread if tight clothing is not provided.

Electrical equipment has been a major factor in igniting hyperbaric fires, and has had some effect in the spread of fire. No electrical equipment has been approved for use in a pressurized or an oxygen-rich environment. It is desirable to keep all electrical wiring and equipment outside the chamber, but again we run into practical difficulties.

Other combustible contents should be eliminated, including, strange as it may seem, combustible construction. Plywood has been involved in several chamber fires. Some hospital chambers are being constructed of laminated plastic.

Because of the difficulty of providing exclusively noncombustible contents, a built-in, fast operating automatic protective system is necessary, and should be a mandatory requirement. The research work necessary to prescribe the type of system has not been done. The Air Force has shut down all chambers since their January 30th fire Next week they will decide upon a protective system, and install and test it. If it does a satisfactory job, all Air Force chambers will be so equipped before being reactivated.

By all means, do not operate a chamber without first aid fire extinguishing capability. A water hose at each end would be relatively easy to provide and be the most useful.

Although I have not brought the answers that you possibly came to hear, I hope that you have picked up some useful information. This discussion has been more of a status report, updated to this week. I will be glad to hear from any of you with either problems or answers. Thank you. (Also see Appendix C - Bibliography, page 35)

MR. SCHMIDT: Thank you, Tom, for your very interesting presentation. We have about 15 minutes for questions. If you have a question, would you indicate to whom you are directing it? Also, I would like it very much if you would give your name for the record.

MR. JOSEPH CENZORI (National Aeronautics and Space Administration, Cleveland): I have a question for the Colonel. Did I understand you to say in the beginning of your talk that the hydraulic fluid was considered flammable, and would you explain why it did burn?

COLONEL BOX: I said according to the definition of a flammable liquid, it was not a flammable liquid. However, under certain conditions it would burn, and as we demonstrated in the film, it did burn. It was really being atomized out of the rupture in the hose, and the ignition source was there in the form of the electrical arc, and it burned.

MR. CENZORI: What did you say was the main reason for it burning -- because it was being atomized?

COLONEL BOX: I am no authority in the fire area. It would just be supposition on my part from the remarks that have been made by experts in this area. I believe atomization did contribute to this. Also, the fact that you had a welding arc there with temperatures in the vicinity of 2500° would be a very good ignition source.

MR. GIFFORD COOK (Air Force): As a matter of information, was any attempt made in the tests in the test cell at Edwards to take measurements for evaluating the atmospheric environment effect?

COLONEL BOX: No, this was an open test cell at Edwards Air Force Base. It was not restricted as a Titan II silo is restricted in area.

MR. W. L. HANBURY (Federal Fire Council): Colonel, was it actually the striking of the arc or the globules that ignited this fire?

COLONEL BOX: Our tests at Edwards did not determine whether it was the arc or the hot steel globules, as you call it, resulting from striking the arc. One of the two was the source of ignition.

MR. HANBURY: Tom, is high temperature rise and speed of temperature rise two of the big factors in possibly killing people in these restricted chambers, apecial atmosphere?

MR. GOONAN: I cannot speak for all of them. In the Navy chamber fire, the onset of the fire was so swift that the amount of monoxide absorbed by the victims was around , I think, two percent for one and four or five percent for the other, where in a typical asphixiation fire you might find concentrations of fifty to sixty percent, so that in at least this fire it was the effect of the fire itself and not the products of combustion that caused the fatalities.

MR. COOK: I want to make an observation. I was particularly impressed with Tom's candor and willingness to put himself on the line. I mention that to give special recognition. And, I particularly want to emphasize the point he made about the causes being interesting, but that the investigations of the fire causes are frequently the reasons for our going off on tangents as to the real problem. I think he made that point very well, and I think it is something that a great many of us ought to bear in mind and try to put across. We frequently are distracted by emphasis on the immediate cause. This applies to all types of fires, not only to those with special atmospheres.

MR. SCHMIDT: If there are no further questions, I would like to again thank our speakers for their excellent presentations and for taking time from their busy schedules to be with us this morning. They have given us a great deal to think about.

Now, as a concluding feature of our session this morning, we will view a new film just released by the Underwriters' Laboratories, entitled "Testing - Requisite for Fire Safety". This will be the premier showing of this motion picture to Federal fire safety personnel.

This particular film was developed by Underwriters' Laboratories, Inc. to convey the concept that fire safety requires the combined efforts of architects, contractors, engineers, building code interests, firefighters, manufacturers, and others; and to show how the services of the Underwriters' Laboratories relate to each of the members of what might be described as the fire safety team.

We are indebted to Underwriters' Laboratories, Inc. for providing us with this film for showing. It is about 20 minutes long, so I hope that you will be able to remain for the showing.

(FILM SHOWN.)

(Meeting was adjourned at 11:50 a.m.)

APPROVED:

W. L. Hanbury

W. L. Hanbury, Secretary

September 22, 1967

Date

APPENDIX A

ANNUAL COMMITTEE REPORTS - 1966

EXECUTIVE COMMITTEE

W. L. Hanbury

During 1966, the Committee:

1. Reviewed, coordinated and provided leadership for committee activities to assure continuity of operation and accomplishment of desired goals.

2. Appointed an Ad-hoc group to review Executive Orders establishing the Council. The Executive Orders were last revised in 1951 and several changes have occurred which suggest up-dating. Also, reissuance would help highlight fire safety again as an area of concern in the Federal Government.

3. Appointed a subcommittee to study the need for fire safety policy statements for the Federal Government. Adequate guidance is not now provided and recommended policy statements would be issued for the information and use of Federal agencies.

4. Endorsed changes in the fire safety reference library operations to make them better, faster, and more complete.

5. Nominated three Federal representatives to provide appropriate liaison with two National Fire Protection Association committees. The NFPA appointed the nominees.

W. L. Hanbury
Chairman

COMMITTEE ON DESIGN STANDARDS

As a result of a request, the Committee surveyed and studied the problem of fire hazards of plastic office partitions. The following recommendation was forwarded to the Federal Supply Service:

> "The fire potentials to life and property presented by the plastic are excessive. Therefore, it is recommended that the fire hazard characteristics of the plastic material be limited to fire hazard ratings not exceeding 25 for flame spread, 100 for smoke development when tested in accordance with ASTM Standard E-84."

COMMITTEE ON DESIGN STANDARDS (CON.)

H. E. Nelson

A subcommittee was named, at the request of the Assistant Administrator for Finance and Administration, General Services Administration, to re-examine the Recommended Practices for Fire Protection of Essential Electronic Equipment. A review and up-dating of the March 1962 document was started and a January 1968 target date for completion was set.

The Committee sponsored the Council's Special Meeting on December 15, 1966, which featured a panel discussion on "Air Handling Systems" Interest was high and the meeting was well attended.

During the coming year the Committee will direct its activities toward the needs for protecting electronic equipment, fire safety involving air handling systems, and fire hazard characteristics of materials.

H. E. Nelson
Chairman

COMMITTEE ON EDUCATION AND TRAINING

Joseph C. Caldwell

The following items were accomplished during 1966:

1. Issued 3,000 spring cleanup kits containing 16 items each, 25,000 spring cleanup posters, and 40,000 fire prevention week posters to help agencies in their fire safety promotion efforts.

2. Elected Joseph C. Caldwell of the Federal Aviation Agency as its Chairman after Thomas J. Creswell resigned.

3. Prepared and coordinated for issuance in the near future a suggested fire protection engineer trainee agreement to meet requests from several agencies. A suitable guide does not exist at present. In addition to a sample agreement, suggested training projects, job descriptions, and other aids are included.

4. Started a project to identify fire safety films available for use by Federal personnel. The need for additional visual aids for educating and training was the subject of the largest number of requests made of the Council during the year. An initial request for information has been sent out. Listings will be issued during the coming year on an agency by agency basis.

COMMITTEE ON EDUCATION AND TRAINING (CON.)

5. All Federal agencies were asked for information on illustrated lectures and displays to assist in fire prevention training and education. This project will be pursued on a continuing basis since emphasis will shift from time to time and this project is very helpful to the majority of those the Council serves.

6. Work was started on updating the "Fire Safety Training Directory". It was originally issued in 1964 and new courses have been started and changes have been made in old courses.

Joseph C. Caldwell
Chairman

COMMITTEE ON FIELD ACTIVITIES

Continuing progress was made in reaching the personnel in the field. Eleven new affiliations were granted as follows: Central Alaska FSC (Federal Safety Council); Greater Cincinnati FSC; Columbia (S. C.) FSC; Denver FSC; Kansas City FSC; Little Rock, Arkansas FSC; Greater Los Angeles FSC; and the Thunderbird (Crown Point, New Mexico) FSC. This brings the total number of field units up to 23 affiliations and two Chartered Field Federal Fire Councils. The number of Federal field personnel automatically receiving Council publications has increased until now it totals over 1,400.

Four program suggestions were sent to all field groups to assist in planning suitable meetings. Feedback from field personnel indicates that they find our material useful.

The "Story of the Federal Fire Council" (in slides with script) was ready for distribution. It will be routed to field groups for showing in 1967 so they will be better informed as to the services offered by the Council.

E. G. Huddleston, Jr.
Chairman

COMMITTEE ON FIRE LOSS EXPERIENCE

Approximately 3,200 copies of a condensed report on "Federal Fire Experience for Fiscal Year 1965" was issued in September. This briefer report was tailored to the needs of administrators and managers. In addition, the customary detailed version was sent in accordance with special requests.

A copy of the condensed report was sent to all agencies by letter requesting comments on ways they intended to gain reductions in the incidence and severity of unwanted fires. This procedure would promote the exchange of information on methods and procedures to reduce fire losses throughout the Federal community.

The Committee Chairman, Mr. L. B. Hicks, was designated to represent the Council on the National Fire Protection Association's Committee on Fire Reporting to provide needed liaison for Federal interests.

COMMITTEE ON FIRE LOSS EXPERIENCE (CON.)

L. B. Hicks

Current activities of the Committee include:

1. Preparation of the "Fire Experience Report for Fiscal Year 1966" (both detailed and condensed versions).

2. Revision of FFC Form No. 9 (Bureau of the Budget approval expires April 30, 1967).

3. Publications of lessons learned from significant fires to highlight areas of concern and speed information exchange.

4. Participation in the suggested 5-year goals of the Council.

L. B. Hicks
Chairman

COMMITTEE ON FIRE PREVENTION

R. B. Smith

During the past year, the Committee reviewed the Council's fire safety inspection forms to evaluate the possible need for modifications. Existing forms are considered adequate for present needs.

The Committee recently accepted the assignment of developing a comprehensive home fire prevention program tailored to Federal needs. This program will answer requests for guidance to combat recent trends of more fires and fire deaths in housing under Federal control.

R. B. Smith
Chairman

COMMITTEE ON PROGRAM

Paul McDonald

Arrangements for the three full Council meetings were made in 1966. The programs covered such topics as the future of the municipal fire service, industrial fire safety, new fire safety products and techniques, and air handling systems. In addition, several new and/or novel films were viewed at an informal film showing.

The Field Demonstration Day, jointly sponsored with the University of Maryland in June, was well attended and emphasis was given to building materials used in construction, salvage, fire detection techniques, and other subjects.

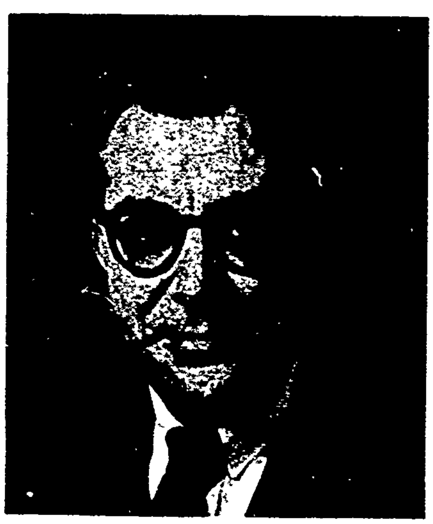
The full Council meetings planned for 1967 are:

April 5	--	Annual Meeting
Summer	--	Film Festival
Fall	--	To Be Announced

The Committee agreed to announce fire safety activities on a calendar year basis. "Fire Safety Activities for 1967" was readied for issuance.

Paul McDonald
Chairman

COMMITTEE ON PROTECTION OF RECORDS



Charles A. Sterman

The Committee participated in the review of several records protection practices and projects pertaining to storage of magnetic tape and testing of fire resistive cardboard cartons. Committee membership was increased to provide the required manpower and diverse representation needed to perform current and future projects.

A Task Group on Records was appointed to study the storage and protection of magnetic tape. The Task Group, after exploring agency positions on problems related to fire protection of magnetic tape, may propose that the statement in RP-1, Fire Protection for Essential Electronic Equipment, be revised.

COMMITTEE ON PROTECTION OF RECORDS (CON.)

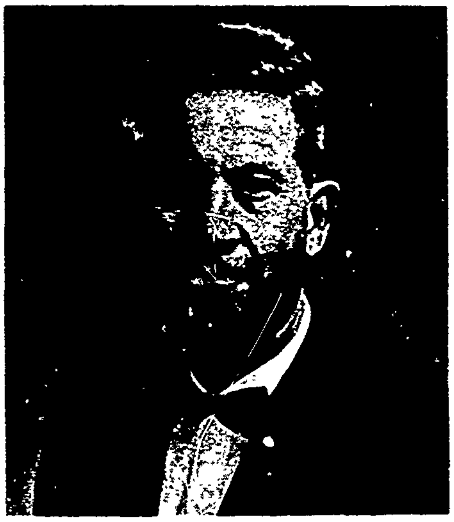
Two members of the Committee participated in a fire test of fire resistive paper and cardboard cartons used for records storage. Two types of cartons were flame tested: (1) cartons treated with an intumescence coating and (2) cartons manufactured from ordinary paper stock. Additional fire testing will be carried out before results are considered by the Committee.

Each Committee member is reviewing the use of open shelf filing equipment in his agency to assess fire hazards and to determine what additional fire protection measures should be established to safeguard records.

Two Committee members are studying conditions in their respective agencies which may point to the need of providing reports covering unplanned destruction of records by accidental fire, flood, or other damaging forces.

Charles A. Sterman
Chairman

COMMITTEE ON RESEARCH AND TECHNOLOGY



R. L. Tuve

The Committee has determined that it could best encourage the application of research findings and foster the technology of fire protection by interpreting or adopting to practical terms the results which appear in various incompletely circulated technical reports on fire research subjects. Accordingly, the first series of "Research Report Digests," authored by members of the Committee, are in process of publication and will be distributed to all Federal Fire Council mailing lists in the near future.

The institution of an annual technical progress award program by the Federal Fire Council is being studied. A subcommittee is conducting a survey of the general nationwide picture of awards for technical progress in fire subjects. Recommendations will be reported at a later date.

The Committee has studied various methods of using information retrieval in connection with the technical literature of fire protection and methods of reporting research projects currently underway. Of these, the type of report used by the Science Information Exchange of Smithsonian Institution is the most useful technical information oriented system for universal use and the Committee has endorsed its use. Others will be encouraged to use the SIE system to provide the needed focal point for fire research activities throughout the Nation.

R. L. Tuve
Chairman

COMMITTEE ON SYSTEMS AND EQUIPMENT

Harry Shoub

In response to requests the following items were considered and replies made:

1. Underwriters' Laboratories, Inc. (#7) "Safety Standards for Soda-Acid Fire Extinguisher" for submission as an USASI Standard.

2. National Fire Protection Association (#74-T) "Household Fire Warning Systems".

3. Federal Specification O-E-915, Extinguisher, Fire, Dry Chemical (Portable).

4. Proposed Federal Specification O-F-555c, Foam-Forming Liquids, Concentrated Fire Extinguisher, Mechanical.

5. "Goodtite" Fire Hose Couplings and Hose Mender.

The Federal Fire Council Recommended Practices No. 3, "Hazards of Carbon Tetrachloride Extinguishers" was prepared for publication. It recommends immediate removal of all carbon tetrachloride extinguishers from Federal operations due to the toxic hazard and poor maintenance and extinguishing characteristics.

A study was started on the "Comparative Cost Data on Various Fire Protection Systems and Components". Suitable information for estimating purposes is not available. A study of the various types of detectors and detection systems was iniated. There is need to develop a listing of strong and weak points of the various systems to meet frequent requests.

The previously completed information on the description of hand portable fire extinguishers, with recommendations on the types to be used, is being up-dated and will be reissued with a revised fire extinguisher chart to provide needed guidance.

Harry Shoub
Chairman

STAFF REPORT

The Staff reports the following significant accomplishments in 1966:

Speaking Engagements: During 1966 the Staff presented five talks before various audiences. Following lists the title, speaker, place and dates:

"The Federal Fire Council Story" by the Staff Director to the fire protection engineers from the field division of the Navy at their annual conference in Washington, D. C. on January 28.

STAFF REPORT (CON.)

E. H. Bolles

The Staff Director served as a panel member to discuss sections of the Building Exits Code at a course for firefighters at the University of Maryland on April 4.

"How to Measure Fire Prevention Activities" by the Staff Director to a seminar on fire prevention contest entries at Fort Meade on April 29, 1966.

"Hospital Fire Prevention" by Assistant Staff Director to the hospital division of the American Society of Safety Engineers Seminar on April 28.

"The Federal Fire Council" by Assistant Staff Director to the Potomac Area Chapter Federal Safety Council on November 8.

Staff Visits. There were 21 occasions during the year when the Staff visited with representatives of Federal agencies in their offices. In addition, 79 persons visited the Council's Staff office. This latter group includes representatives from trade and professional associations, research and testing groups, fire safety equipment manufacturers, as well as personnel from Federal agencies. The Staff assists in bringing together personnel from Federal agencies and visitors, such as employees of Underwriters' Laboratories, Inc., and the National Fire Protection Association, to discuss subjects of mutual interest.

The Staff answered about 900 requests for specialized fire safety information.

Indoctrination in the functions of the Federal Fire Council was presented to 9 representatives from foreign countries and to 15 trainees from Federal agencies.

Over 200 man-hours were expended by the Staff attending and participating in numerous fire safety meetings. In addition, 74 man-hours were spent at Federal agencies or groups in special meetings.

The Staff received a total of 118 hours of formal training in various subjects so as to improve their effectiveness.

Library Operations. As reported last year the Council library material has been physically located in the General Services Administration's Central Office Library, (Room G-13, 19th & F Streets, NW., Washington, D. C. 20405). The GSA Library operates the loan service, provides the cross-reference cards and is willing to make bibliographical searches. The Council Staff is responsible for the acquisition of the new materials. During the year 716 items were accessioned. The library made 615 loans. There is now a separate reading room for Council material and a microfilm reader has been obtained for use with the Council's library.

STAFF REPORT (CON.)

Each year more bibliographies are requested from the Council. Such queries are answered through use of the facilities of the Defense Documentation Center, the GSA Library, and the Staff.

Visual Aids. The Council's Visual Aid Service is growing, both in size and usefulness. Presently there are 14 fire safety motion picture films and more than 20 sets of 35 mm slides with scripts, tapes, and/or records. Most of these are on active loan. Last year the aids had been loaned over 100 times. In August a list of about 22 items was published and the immediate response was overwhelming. Over 200 requests were received for material for Fire Prevention Week alone. Through extensive efforts about 75 of these requests were honored by obtaining the help from HEW Communicable Disease Center and PHS Regional Offices plus assistance from the Air Force and Veterans Administration.

Other items of interest. The Council was able to help the National Fire Protection Association in the screening of Fire Prevention Contest Entries through the affiliated group in Boston, Massachusetts.

The Federal Fire Council Story in slide form, with script, was completed and multiple copies obtained for loan to field groups.

Materials Printed and/or Distributed by the Council in 1966:

1. Minutes of Meetings of the Council:

Special Meeting, December 15, 1966	3,600
Annual Meeting, April 12, 1966	3,600

2. Special Issuances to all FFC mailing lists:

Fire Experience FY 65(Condensed)	3,500
Newsletters	6,200
Federal Fire Council Folder	5,000
Speeches	7,800
Federal Fire Council Film List	3,000
Federal Fire Council Publications List	6,300
Film Previewings - Announcements of Meetings	4,700
Spring Clean-up Kit Evaluation	1,500

3. Special Issuances to Principal Members of FFC:

Twelve Fire Safety Information Transmittal Letters -- containing 82 items	10,250
Requests for Displays	150
Requests for Illustrated lectures	150

STAFF REPORT (CON.)

4. Miscellaneous

FFC Fire Prevention Week Posters	114,500
Spring Clean-up Kit - 16 items in each of 3,000 Kits	48,300
Requests for Visual Aids Information	3,100
Library Accession Lists (Six Issues)	20,400
Annual Meeting Announcement April 1966	2,800
Special Meeting Announcement December 1966	3,600
Field Day Announcement, Maps, Programs	6,200
Six Special Issuances to FFC Members	1,900

TOTAL NUMBER OF COPIES PRINTED AND/OR DISTRIBUTED:

258,35[illegible]

E. H. Bolles
Assistant Staff Director

APPENDIX B - ATTENDANCE

The following is a list of Federal Fire Council members and guests who registered at the meeting:

COUNCIL MEMBERS

Alexander, W. H.	General Services Administration
Barrow, J. T.	Veterans Administration
Bertsch, V. R.	Interior
Black, J.	Health, Education, and Welfare
Bolles, E. H.	Federal Fire Council
Bradley, R. A.	Veterans Administration
Brannigan, F.	Atomic Energy Commission
Bright, R. G.	General Services Administration
Callahan, I. G.	Housing and Urban Development
Carmalt, W. B.	Army
Casey, M. P.	Air Force
Castle, C. F.	Defense
Clark, H. F.	Transportation
Clark, L. E.	Veterans Administration
Coble, J. B.	Health, Education, and Welfare
Cook, G. T.	Air Force
Coughlin, J. J.	Treasury
Crowe, B. A.	Federal Fire Council
Cummings, J. W.	General Services Administration
DeHart, C. W.	General Services Administration
Fitzpatrick, J. J.	Army
Hanbury, W. L.	Federal Fire Council
Haon, M. B.	General Services Administration
Hicks, L. B.	Navy
Jones, J. C.	Interior
Johnsen, J. A.	General Services Administration
Kennedy E. F.	Interior
Krause, E. L.	Veterans Administration
LeClerg, R. E.	Interior
Logan, C. A.	Agriculture
Lytle, H. O.	Railroad Retirement Board
Maday, D. S.	Veterans Administration
Martin, A. E.	Labor
May, W. R.	Treasury
McCann, R. B.	Navy
McKerahan, D. C.	Interior
Middlesworth, C. M.	Federal Aviation Agency
Morehouse, A.	Veterans Administration
Murphy, G. E.	Interior
Nelson, H. E.	General Services Administration
Newcomer, G. M.	National Aeronautics and Space Administration
Noser, W. F.	Army
Palme, F. J.	Veterans Administration
Pettitt, G. H.	Selective Service System
Phillips, R. M.	Post Office
Proctor, J. A.	Labor
Queen, N. L.	Commerce
Rantzow, C. E.	General Services Administration

MEMBERS (CON.)

Reese, L. W.	Health, Education, and Welfare
Reid, G. E.	State
Robitaille, H. A.	General Services Administration
Schmidt, W. A.	General Services Administration
Scott, L. W.	Commerce
Shoub, H.	Commerce
Smith, R. B.	Atomic Energy Commission
Smith, R. J.	National Security Agency
Stott, R.	Interior
Thornton, A. L.	Navy
Tiernan, T F.	Veterans Administration
Tihila, H	National Science Foundation
Trupo, R.	U. S. Information Agency
Weir, F.	General Services Administration
West, E. A.	National Aeronautics and Space Administration

GUESTS

Addleman, N. J.	University of Maryland, College Park, Maryland
AlDaag, H.	Embassy of Israel, Washington, D. C.
Bailey, R. H.	Defense Supply Agency, Alexandria, Virginia
Baker, J. F.	Interior, Washington, D. C.
Balcom, L. H.	D. C. Fire Department, Washington, D. C.
Barraclough, R.	National Foam System, West Chester, Pennsylvania
Beard, N. J.	General Services Administration, Ft. Meade, Maryland
Benefield, W. K.	Transporation, Washington, D. C.
Berry, W. H.	Interior, Washington, D. C.
Bettendorf, J. A.	Interior, Washington, D. C.
Bornes, H. P.	Walter Reed Army Medical Center, Washington, D. C.
Bourne, H. K.	U. K. Scientific Mission, Washington, D. C.
Bower, F. A	DuPont Company, Wilmington, Delaware
Brave, R. M.	Navy, Washington, D. C.
Brogan, J. E.	Veterans Administration, Lyons, New Jersey
Brown, R. W.	General Services Administration, Washington, D. C.
Bryan, J. L.	University of Maryland, College
Byrus, R. C.	National Aeronautics and Space Administration, Beltsville, Maryland
Cenzori, J. D.	National Aeronautics and Space Administration, Cleveland, Ohio
Collins, J. E.	Navy, Philadelphia, Pennyslvania
Crow, T.	Treasury, Washington, D. C.
D'Agostino, P.	General Services Administration, Washington, D. C.

GUESTS (CON.)

Davis, A. E.	International Association of Fire Fighters, Washington, D. C.
DeBose, J. M.	Treasury, Washington, D. C.
Dismake, C. P.	Fairfax County Fire Marshal, Fairfax, Virginia
Dowling, J. H.	DuPont Company, Wilmington, Delaware
Ely, R. K.	Interior, Washington, D. C.
Farmer, H. C.	Walter Reed Army Medical Center, Washington, D. C.
Golliday, R.	General Services Administration, Washington, D. C.
Good, D. P.	General Services Administration, Washington, D. C.
Gross, D.	Commerce, Gaithersburg, Marylard
Gue, H. R.	Walter Reed Army Medical Center, Washington, D. C.
Hailey, E. G.	General Services Administration, Washington, D. C.
Hammerman, D.	Fire Marshal's Office, Baltimore, Maryland
Hart, F. I.	Navy, Washington, D. C.
Holthaus, G. J.	Veterans Administration, Baltimore, Maryland
Howe, W. R.	Interior, Washington, D. C.
Innamorati, A. W.	General Services Administration, Washington, D. C.
Jarvis, P. A.	Health, Education, and Welfare, Bethesda, Maryland
Jedd, W. C.	Civil Service Commission, Washington, D. C.
Kaufhold, J. T.	Army, New Cumberland, Pennsylvania
Kelly, B. M.	Veterans Administration, Lyons, New Jersey
Kennedy, A. F.	Ft. Myer Fire Department, Ft. Myer, Virginia
Kilborn, R. W.	National Forest Products Association, Washington, D. C.
Kirby, N. L.	Naval Academy, Annapolis, Maryland
Klinker, R. L.	Navy, Washington, D. C.
Koerner, O.	Housing and Urban Development, Washington, D. C.
Legg, R. W.	Retired, Washington, D. C.
Livingston, W. L.	Factory Mutual Research Corporation, Norwood, Massachusetts
McLaughlin, T. B.	Navy, Washington, D. C.
McSmith, D.	National Aeronautics and Space Administration, Hampton, Virginia
Mobley, J. M.	Federal Aviation, Agency, Washington, D. C.
Moran, H. E.	Navy, Washington, D. C.
Mullen, C. S.	State Fire Marshal, Richmond, Virginia

New, J. H.	Central Intelligence Agency, McLean, Virginia
Olsen, W. R.	Veterans Administration, Washington, D. C.
Osborn, J. M.	General Services Administration, Washington, D. C.
Parsons, R. L.	Naval Academy, Annapolis, Maryland
Phillips, D. G.	County of Fairfax, Fairfax, Virginia
Phillips, W. H.	D. C. Fire Department, Washington, D. C.
Queen, W. G.	Army, Washington, D. C.
Ramisch, J. L.	Interior, Washington, D. C.
Rollins, C. M.	Interior, Washington, D. C.
Roydhouse, C. E.	Navy, Annapolis, Maryland
Schidlovsky, A.	John Hopkins University, Silver Spring, Maryland
Sellner, H. E.	Navy, Bethesda, Maryland
Seymour, T. H.	Labor, Washington, D. C.
Shipley, J. C.	State Fire Marshals Office, Alexandria, Virginia
Shope, L. D.	Army, New Cumberland, Pennsylvania
Smith, T.	Navy, Bethesda, Maryland
Smithson, M. V.	National Capital Region, Washington, D. C.
Stahl, R. W.	Interior, Washington, D. C.
Stevenson, G. D.	John Hopkins University, Silver Spring, Maryland
Thorsell, E. R.	Federal Aviation Agency, Washington, D. C.
Thune, H. P.	Post Office, Washington, D. C.
Tilden, P. V.	Retired, Washington, D. C.
Tuman, E. W.	Army, New Cumberland, Pennsylvania
Tyler, J. A.	Army, Washington, D. C.
White, P. S.	General Services Administration, Washington, D. C.
Williams, R.	Navy, Washington, D. C.

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